PATENT ABSTRACTS OF JAPAN

(11)Publication number : 06-068896

(43)Date of publication of application : 11.03.1994

(51)Int.Cl. H01M 8/10
H01M 8/02
H01M 8/04

(21)Application number : 04-220529

(22)Date of filing : 20.08.1992

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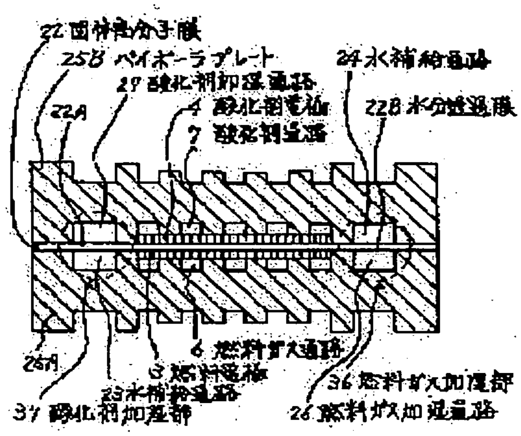
(54) CELL STRUCTURE OF SOLID POLYMER ELECTROLYTIC FUEL CELL

(57)Abstract:

PURPOSE: To provide a solid polymer electrolytic fuel cell for which a humidification part, which is easily assembled and has good humidification ability, and which also contributes to cooling of the fuel cell, is integrated therein.

CONSTITUTION: A plurality of solid polymeric films 22 having ion conductivity, and a plurality of single cells consisting of a fuel electrode 3 and an oxidant electrode 4 that are adhered to the both surfaces of the film 22, are formed through bipolar plates 25A, 25B having a fuel gas channel 6 consisting of recessed groove and an oxidant channel 7, in the part opposed to the fuel electrode and to the oxidant electrode on the both surfaces of a gas non-permeation plate. The solid polymeric film 22 is extended to a fixed length in the both directions of the fuel electrode 3 and the oxidant electrode 4 which are opposed to one another, and a humidification part 36 of fuel gas is provided on the side of one extended part 22B while a humidification part 37 of oxidant is provided on the side of the other extended part 22A, with the extended parts serving as water permeation films.



LEGAL STATUS

[Date of request for examination]	18.09.1998
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3147518
[Date of registration]	12.01.2001
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]

[Claim 1] The single cel which consists of a solid-state poly membrane which has ion conductivity, and the fuel electrode and oxidizer electrode arranged by sticking to the both sides In the solid-state polyelectrolyte mold fuel cell by which two or more layer laminating was carried out to the part which counters said fuel electrode of both sides of a gas impermeable plate, and each oxidizer electrode through the bipolar plate which has the fuel gas path and oxidizer path which consist of a concave Die-length extension of predetermined is carried out at the method of both sides of said fuel electrode with which said solid-state poly membrane counters mutually, and an oxidizer electrode. The cellular structure of the solid-state polyelectrolyte mold fuel cell characterized by preparing this extension in one extension and coming to prepare the humidification section of an oxidizer in the humidification section of fuel gas, and the extension of another side as transparency film of moisture.

[Claim 2] The cellular structure of the solid-state polyelectrolyte mold fuel cell according to claim 1 characterized by consisting of a water supply path formed as a concave which became independent into the part to which the humidification section counters the extension of a solid-state poly membrane, the gas humidification path which while pinches this and is open for free passage to a bipolar plate at a fuel gas path or an oxidizing agent path, and which was formed as a concave, and said gas humidification path of the bipolar plate of another side.

[Claim 3] The cellular structure of the solid-state polyelectrolyte mold fuel cell according to claim 2 characterized by arrangement of the gas humidification path in two extensions of a solid-state poly membrane and a water supply path being mutually allotted to a symmetric position to a solid-state poly membrane, one side forming the humidification section of fuel gas, and another side coming to form the humidification section of an oxidizer.

[Claim 4] The cellular structure of the solid-state polyelectrolyte mold fuel cell according to claim 2 characterized by being formed and becoming so that the fuel gas or the oxidizer with which the gas humidification path passed along this may make a U-turn and it may flow into a fuel gas path or an oxidizer path.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the solid-state polyelectrolyte mold fuel cell stack which used the solid-state poly membrane as an electrolyte membrane, and the cellular structure for humidifying a solid-state poly membrane especially.
[0002]
[Description of the Prior Art] Drawing 4 is the sectional view in which, and showing it, and the single cel 1 consists of a solid-state poly membrane 2 which has ion conductivity, and the fuel electrode (anode electrode) 3 and the oxidizer electrode (cathode electrode) 4 supported so that it might stick to the both sides. [the single cellular structure of a solid-state polyelectrolyte mold fuel cell] [**] [type] Moreover, the bipolar plate 5 which pinches the single cel 1 consists of a gas impermeable plate which has conductivity. By supplying the oxygen as an oxidizer to the oxidizer path 7 formed in the fuel gas path 6 formed in the field side which touches the fuel electrode 3 as a concave as a concave in the hydrogen as fuel gas at the field side which touches the oxidizer electrode 4 The generation of electrical energy based on electrochemical reaction is performed by inter-electrode [of the pair of the single cel 1]. In addition, the solid-state polyelectrolyte mold fuel cell of desired output voltage is obtained by carrying out two or more layer laminating of the single cel 1 and the bipolar plate 5 to less than [1V], since the output voltage of the single cel 1 constituted in this way is low, and constituting a stack.
[0003] On the other hand as a solid-state poly membrane 1 which has ion conductivity For example, the thing using the par fluorocarbon sulfonic-acid film (the U.S., Du Pont, trade name Nafion) which is proton exchange film as an electrolyte membrane is known. They are 20 ohm-cm at ordinary temperature by having and carrying out the saturation water of the proton (hydrogen ion) exchange group into a molecule. While the following specific resistance is shown and functioning as a proton conductivity electrolyte, it functions also as a diaphragm which prevents mixing of fuel gas and oxidant gas. Namely, the anode reaction ($H2 -> 2H^{+} + 2e^{-}$) which decomposes a hydrogen content child into a hydrogen ion and an electron in an anode electrode (fuel electrode) side A cathode reaction is performed, respectively. in a cathode electrode (oxidizer electrode) side, water is generated from oxygen, a hydrogen ion, and an electron — electrochemical reaction ($2H^{+} + 1/2\ O2 + 2e^{-} -> H2\ O$) — Electrochemical reaction which 2 O2 ->H2 O [H2+1/] Becomes as a whole is performed, and generated output is supplied to a load with the electron which moves toward a cathode in an external circuit from an anode.
[0004] As mentioned above, while maintaining the inside of the solid-state poly membrane 2 to a saturation moisture state in order to maintain highly the generating efficiency of a solid-state polyelectrolyte mold fuel cell since the film functions as proton exchange film when solid-state polyelectrolyte type ********** carries out the saturation water of the electrolyte membrane, it is 50-100-degreeC about the operating temperature of a solid-state polyelectrolyte mold fuel cell. It is necessary to hold to extent and to keep low the specific resistance of a solid-state poly membrane. For this reason, after the solid-state polyelectrolyte film 2 of each ** cel 1 has carried out the water of the water of a saturation content beforehand, assembly operation of a stack is performed. However, if it generates electricity by raising an operating temperature to the above-mentioned temperature requirement, the desiccation operation of the solid-state poly membrane 2 shown below occurs, the solid-state poly membrane 2 cannot be maintained to a saturation moisture state, but the problem that the generating efficiency of a solid-state polyelectrolyte mold fuel cell falls will occur. Namely, proton $2H^{+}$ generated in the anode reaction while the water generated by electrochemical reaction by fuel gas and oxidant gas was carried out out of the system In case the inside of a solid-state poly membrane is turned to a cathode from an anode and it moves, desiccation of a solid-state poly membrane advances by a child's water carrying out orientation several minutes, moving to a proton together, and being carried out out of a system with fuel gas and an oxidizer.
[0005] Then, in order to avoid such a situation, water is added to the reactant gas (fuel gas and oxidizer), supplied to the reactant gas paths 6 and 7, the steam concentration in reactant gas (steam partial pressure) is raised, and what was constituted so that evaporation of the moisture from the solid-state poly membrane 2 might be suppressed is known. The tank which collected warm water is prepared for the exterior of a fuel cell as the humidification approach of reactant gas, and the external humidifying method which supplies the reactant gas which BABURINKU, humidified and humidified reactant gas in this molten bath to each ** cel of a solid-state polyelectrolyte mold fuel cell is learned. Moreover, a solid-state polyelectrolyte mold fuel cell is adjoined, the humidification section is prepared, and the internal humidifying method which supplies the reactant gas humidified here to each ** cel is also learned.
[0006] The mimetic diagram in which drawing 5 shows the conventional solid-state polyelectrolyte mold fuel cell of an internal humidification method, and drawing 6 are the mimetic diagrams showing the humidification section in the conventional internal humidification method. In drawing, the solid-state polyelectrolyte mold fuel cell 10 adjoins the side attachment wall, and supplies the fuel gas and the oxidizer which equipped with and humidified the humidification section 11 of reactant gas, respectively to the fuel gas path 6 and the oxidizer path 7 of each ** cel. It considers as the transparency film 12A and 12B. the solid-state poly membrane (membrane filter) in which the humidification section 11 does not have electronic conductivity as shown in drawing 6 — humidification — service water — It is constituted so that the field side which is one side, respectively may counter the humidification water path 13 and the field of another side may counter the fuel gas humidification room 16 or the oxidizer humidification room 17. the humidification which carried out humidity with the water heated by exhaust heat of a fuel cell — service water — a steam is generated from transparency film 12 front face, and the fuel gas and the oxidizer which were humidified with this steam are supplied to the fuel gas path 6 and the oxidizer path 7 of each ** cel of the solid-state polyelectrolyte mold fuel cell 10, respectively.
[0007]

[Problem(s) to be Solved by the Invention] since heat insulation and heating of piping be need in order to prevent the reactant gas humidified by the tank condense in piping between fuel cells in an above-mentioned external humidification method , and the heat source for heating of a tank be need , there be a problem of cause decline in the thermal efficiency of a solid-state polyelectrolyte mold fuel cell , and there be a fault that equipment also become large-scale .
[0008] On the other hand, since a fuel cell stack is adjoined and the humidification section is arranged in an above-mentioned internal humidification method, use of exhaust heat of the fuel cell as a heat source of steam generating is easy, and there is an advantage which can also simplify the gas piping between the humidification section and a fuel cell. However, a fuel cell is the isolated system which used the poly

membrane without the ion conductivity of another object as moisture transparency film, and the components mark also have the problem that and assembly operation becomes complicated. moreover — although it is expected that it is possible to use the latent heat of vaporization of make up water for humidification for cooling of a fuel cell, and the humidification section can be used also [cooling plate] if the laminating of the humidification section can be carried out between the layers of a single cel -- humidification -- service water — since the conductivity of a stack will be lost if a laminating is carried out between the layers of a single cel, since the transparency film does not have electronic conductivity, the problem that where of the humidification section cannot be made serve a double purpose as a cooling plate of a fuel cell also exists.

[0009] By uniting with a fuel cell stack, the purpose of this invention is easy assembly operation, and its humidification engine performance is good, and it is to acquire the cellular structure of the solid-state polyelectrolyte mold fuel cell equipped with the humidification section which can contribute also to cooling of a fuel cell.

[0010]

[Means for Solving the Problem] The solid-state poly membrane which has ion conductivity according to this invention in order to solve the above-mentioned technical problem, The single cel which consists of the fuel electrode and oxidizer electrode which were arranged by sticking to the both sides In the solid-state polyelectrolyte mold fuel cell by which two or more layer laminating was carried out to the part which counters said fuel electrode of both sides of a gas impermeable plate, and each oxidizer electrode through the bipolar plate which has the fuel gas path and oxidizer path which consist of a concave Die-length extension of predetermined is carried out at the method of both sides of said fuel electrode which counters mutually, and an oxidizer electrode, as transparency film of moisture, this extension shall be prepared in one extension and said solid-state poly membrane shall come to prepare the humidification section of an oxidizer in the humidification section of fuel gas, and the extension of another side.

[0011] Moreover, the humidification section shall consist of a water supply path formed as a concave which became independent into the part which counters the extension of a solid-state poly membrane, the gas humidification path which while pinches this and is open for free passage to a bipolar plate at a fuel gas path or an oxidizing agent path, and which was formed as a concave, and said gas humidification path of the bipolar plate of another side. Furthermore, arrangement of the gas humidification path in two extensions of a solid-state poly membrane and a water supply path is mutually allotted to a symmetric position to a solid-state poly membrane, one side shall form the humidification section of fuel gas, and another side shall come to form the humidification section of an oxidizer.

[0012] About a gas supply path, it shall form and become further again so that the fuel gas or the oxidizer which passed along this may make a U-turn and it may flow into a fuel gas path or an oxidizer path.

[0013]

[Function] In the configuration of this invention, predetermined carried out die-length extension of the solid-state poly membrane which has the ion conductivity of each ** cel of a solid-state polyelectrolyte mold fuel cell at the method of both sides of a fuel electrode and an oxidizer electrode, and it constituted so that this extension might be prepared in one extension and the humidification section of an oxidizer might be prepared in the humidification section of fuel gas, and the extension of another side as transparency film of moisture. Namely, the gas humidification path formed as a concave which while pinches a solid-state poly membrane and is open for free passage to a bipolar plate at a fuel gas path or an oxidizer path If it constitutes so that the water supply path formed as a concave which became independent into the part which counters the gas supply path of the bipolar plate of another side may be prepared and it may consider as the humidification section By forming in the bipolar plate the configuration of the concave formed beforehand corresponding to the gas humidification path and the water supply path Since the solid-state polyelectrolyte mold fuel cell equipped with the humidification section of the reactant gas unified without changing most laminated structures of a solid-state polyelectrolyte mold fuel cell for every single cel can be constituted, the function to avoid the increment in components mark and the number of erectors is obtained. Moreover, since it excels in the humidification engine performance of a solid-state poly membrane by that of humidification ******** for every ** cel and the shift of moisture to a body part from the extension of a solid-state poly membrane can also be expected, the high desiccation prevention function of a solid-state poly membrane is obtained. Furthermore, since the humidification section united with both the sides of a single cel takes the generation-of-electrical-energy heat of formation of a single cel as the latent heat of vaporization of a steam, the humidification section serves as a cooling plate with a quick speed of response, and the function to improve the temperature distribution of a solid-state polyelectrolyte mold fuel cell is obtained.

[0014] Furthermore, if it constitutes so that arrangement of the gas supply path in two extensions of a solid-state poly membrane and a water supply path may be mutually made into a symmetric position to a solid-state poly membrane, the humidification section of fuel gas can be formed in one extension, without not affecting the humidification section of an oxidizer on the extension of another side, but affecting the configuration of a solid-state polyelectrolyte mold fuel cell. If it forms so that the fuel gas or the oxidizer which passed along this may make a U-turn and a gas supply path may be flowed into a fuel gas path or an oxidizer path, while not needing the supply path of the humidified reactant gas but being able to reduce the necessary area of the humidification section to necessary minimum further again, the function which supplies a reactant gas path and humidifies a solid-state poly membrane efficiently is obtained without making moisture condense.

[0015]

[Example] Hereafter, this invention is explained based on an example. It is the sectional view in which, and showing it, the top view where drawing 2 looked at the bipolar plate in an example from the fuel gas path side, and the top view where drawing 3 looked at the bipolar plate in an example from the oxidizer path side, and the duplicate explanation is omitted by giving the same reference mark to the same component as the conventional technique. [the cellular structure of the solid-state polyelectrolyte mold fuel cell with which drawing 1 becomes the example of this invention] [**] [type] In drawing, die-length extension of predetermined is carried out at the method of both sides of the fuel electrode 3 with which the solid-state poly membrane 22 which has the ion conductivity which constitutes a single cel counters mutually through this, and the oxidizer electrode 4, and the humidification section 37 of an oxidizer is formed in one extension at the humidification section 36 of fuel gas, and the extension of another side considering this extension as transparency film 22A and 22B of moisture.

[0016] The humidification section 36 of fuel gas uses extension 22B of the solid-state poly membrane 22 as the transparency film of moisture. The fuel gas humidification path 26 as a concave which while pinches this and is open for free passage to bipolar plate 25A at the fuel gas path 6 is formed. By forming the water supply path 24 which consists of a concave which became independent into the part which counters the fuel gas humidification path 26 of bipolar plate 25B of another side, the solid-state polyelectrolyte mold fuel cell equipped with the humidification section 36 of the fuel gas united with each ** cel is constituted. Moreover, as the humidification section 37 of an oxidizer, extension 22A of the solid-state poly membrane 22 is used as the transparency film of moisture. The oxidizer humidification path 27 as a concave which while pinches this and is open for free passage to bipolar plate 25B at the oxidizer path 7 is formed. By forming the water supply path 23 which consists of a concave which became independent into the part which counters the oxidizer humidification path 27 of bipolar plate 25A of another side, the solid-state polyelectrolyte mold fuel cell equipped with the humidification section 37 of the fuel gas united with each ** cel is constituted.

[0017] Moreover, the humidification section 36 of the fuel gas in one single cel and the humidification section 37 of an oxidizer By making mutually arrangement with the gas humidification paths 26 and 27 in two extensions of a solid-state poly membrane, and the water supply paths 23 and 24 into a symmetric position to a solid-state poly membrane The fuel gas humidification path 26 which was open for free passage to the fuel gas path 6, and the oxidizer humidification path 27 which was open for free passage to the oxidizer path 7 can be formed in the

form where the extension of the solid-state poly membrane 22 of one sheet is used.

[0018] Furthermore, as shown in drawing 2 or drawing 3 , the water supply paths 23 and 24 are formed with gas passagewaies 6 and 7 by bipolar plate 25A and rib 28B connected and formed in the seal section 28 by the side of 25B periphery, and water works of make up water are performed through the inlet ports 23A and 24A of make up water which penetrates the seal section 28, and Outlets 23B and 24B, respectively. Moreover, the humidification path 26 of fuel gas or the humidification path 27 of an oxidizer It is formed so that it may have rib 28A between the fuel gas path 6 and the oxidizing agent path 7, the fuel gas or the oxidizing agent passing through a humidification path may make a U-turn and it may flow into the fuel gas path 6 or the oxidizing agent path 7. While being able to supply a fuel gas path or an oxidizer path, without making the moisture in the reactant gas humidified at the humidification path condense, the area which the humidification section occupies is reducible to the minimum.

[0019] The single cel which has the cellular structure which becomes an example make up water in the humidification section 36 and 37 In response to the generation-of-electrical-energy heat of formation of a single cel, it is heated from a single cel to the extension of direct or the cooling plate which is not illustrated. The fuel gas or the oxidizer which the steam was generated on the front face of the moisture transparency film 22A and 22B which carried out humidity, and the reactant gas in the humidification path 26 and 27 was humidified with this steam, and was humidified by the fuel gas path 6 and the oxidizer path 7 which were open for free passage to this is supplied.

[0020] Thus, it sets to the solid-state polyelectrolyte mold fuel cell constituted as a layered product of a single cel which has the constituted cellular structure. By forming in the bipolar plate the configuration of the concave formed beforehand corresponding to the gas humidification path and the water supply path Since the solid-state polyelectrolyte mold fuel cell equipped with the humidification section of the reactant gas unified without changing most laminated structures of a solid-state polyelectrolyte mold fuel cell for every single cel can be constituted While the increment in components mark and the number of erectors is avoided and reduction of a manufacturing cost is attained Since the function for the humidification section to be prepared for every ** cel, and for direct moisture to shift to the body part of a solid-state poly membrane from the extension which the humidification engine performance of reactant gas was good, and carried out humidity, and to prevent desiccation is added The solid-state polyelectrolyte mold fuel cell equipped with the cellular structure which has the advanced desiccation prevention engine performance can be obtained economically and advantageously.

[0021] Moreover, since the humidification section united with both the sides of a single cel takes the generation-of-electrical-energy heat of formation of a single cel as the latent heat of vaporization of a steam, the humidification section serves as the function of a cooling plate with a quick speed of response, and the advantage which can improve the temperature distribution of a solid-state polyelectrolyte mold fuel cell is acquired.

[0022]

[Effect of the Invention] This invention was constituted so that the extension of the solid-state poly membrane as an electrolyte membrane might be prepared in one extension and it might prepare the humidification section of an oxidizer in the humidification section of fuel gas, and the extension of another side as transparency film of moisture as mentioned above. consequently , since the direct use of the heat of formation of a fuel cell can be carry out as a heat source for steam generating , thermal efficiency be high , and while not need a humidification tank and gas piping but being able to simplify the configuration of equipment by unite the humidification section with a fuel cell compared with the solid-state polyelectrolyte mold fuel cell of an external humidification method , when each ** cel be equip with the humidification section , the solid-state polyelectrolyte mold fuel cell equipped with the cellular structure with a high humidification engine performance can be offer economically and advantageously .

[0023] Moreover, since it has the humidification section united with the body of a fuel cell for every ** cel compared with the solid-state polyelectrolyte mold fuel cell of the conventional internal humidification method which put the humidification section side by side to the fuel cell and the direct use of the heat of formation of a fuel cell can be carried out as a heat source for steam generating, the speed of response of the amount of humidification to change of single cel temperature — it is high, and since direct supply of the moisture from the extension of a solid-state poly membrane to a body part is also expectable, the desiccation prevention effectiveness of the outstanding solid-state poly membrane is acquired. Moreover, since components mark and its number of erectors can be reduced by being unified, the economic effects which can reduce a manufacturing cost sharply are acquired. Furthermore, since make up water supplied to the humidification section functions also as cooling water, the same cooling effect is acquired and the repercussion effect which improves the temperature distribution of the direction of a field of a single cel and the direction of a laminating of a solid-state polyelectrolyte mold fuel cell, and improves a cel property can also be expected to have formed the cooling plate in each ** cel.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The sectional view in which, and showing it [the cellular structure of the solid-state polyelectrolyte mold fuel cell which becomes the example of this invention] [**] [type]
[Drawing 2] The top view which looked at the bipolar plate in an example from the fuel gas path side
[Drawing 3] The top view which looked at the bipolar plate in an example from the oxidizer path side
[Drawing 4] The sectional view in which, and showing it [the single cellular structure of a solid-state polyelectrolyte mold fuel cell] [**] [type]
[Drawing 5] The mimetic diagram showing the conventional solid-state polyelectrolyte mold fuel cell of an internal humidification method
[Drawing 6] The mimetic diagram showing the humidification section in the conventional internal humidification method
[Description of Notations]
1 Single Cel
2 Solid-state Poly Membrane
3 Fuel Electrode
4 Oxidizer Electrode
5 Bipolar Plate
6 Fuel Gas Path
7 Oxidizer Path
8 Gas-Seal Section (Rib)
10 Solid-state Polyelectrolyte Mold Fuel Cell (Stack)
11 Humidification Section
12 Humidification — Service Water — Transparency Film
13 Humidification Water Path
16 Fuel Gas Humidification Room
17 Oxidizer Humidification Room
22 Solid-state Poly Membrane
22A The extension of a solid-state poly membrane (moisture transparency film)
22B The extension of a solid-state poly membrane (moisture transparency film)
23 Water Supply Path
24 Water Supply Path
25A Bipolar plate
25B Bipolar plate
26 Fuel Gas Humidification Path
27 Oxidizer Humidification Path
28 Seal Section
28A Rib (for gas U-turn)
28B Rib (for formation of a water supply path)
36 Fuel Gas Humidification Section
37 Oxidizer Humidification Section

[Translation done.]

* NOTICES *

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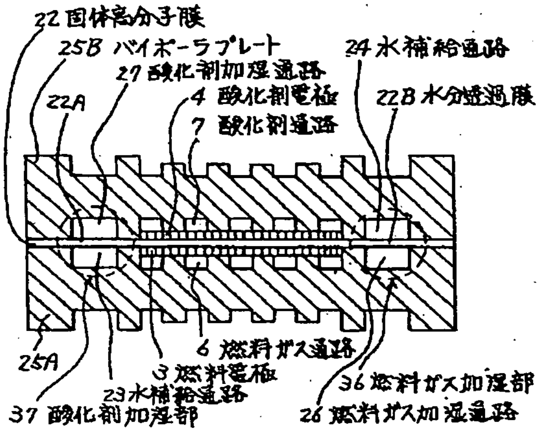
damages caused by the use of this translation.

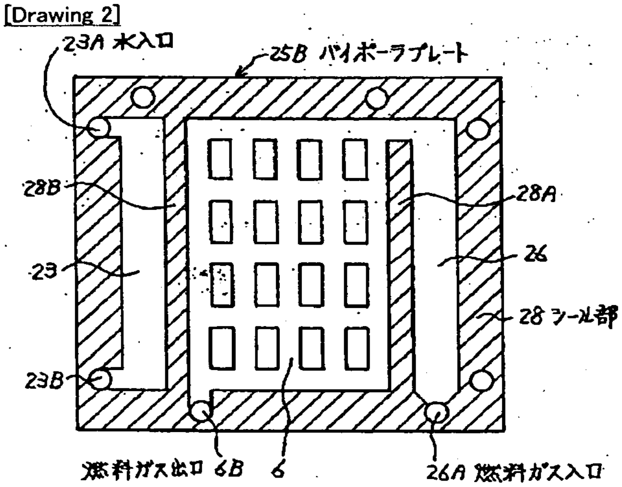
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

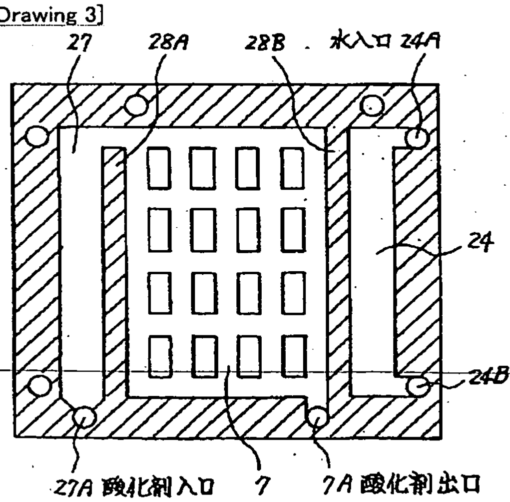
[Drawing 1]



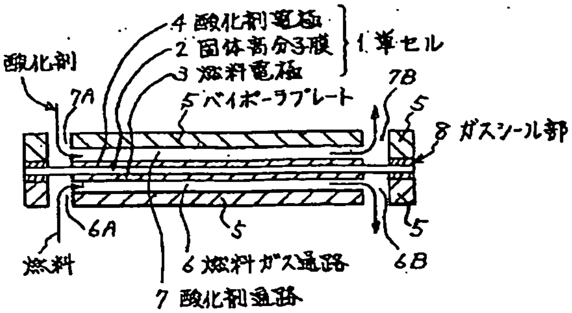
[Drawing 2]



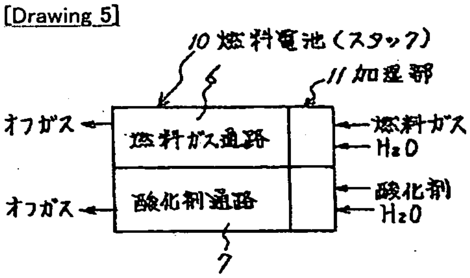
[Drawing 3]



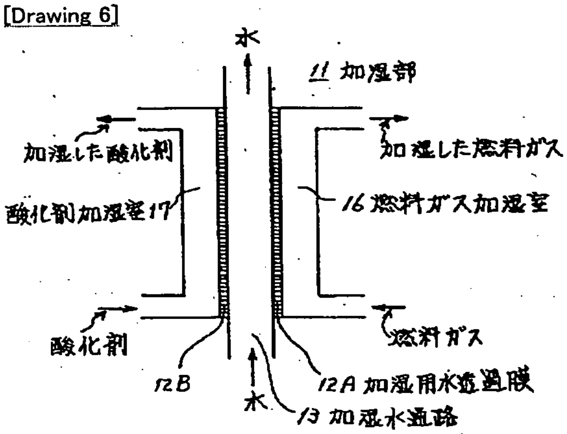
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]

(19)日本国特許庁（ＪＰ）　(12) 公開特許公報（Ａ）　(11)特許出願公開番号

特開平6－68896

(43)公開日　平成6年(1994)3月11日

(51)Int.Cl.⁵		識別記号	庁内整理番号	F I	技術表示箇所
H01M	8/10		9062－4K		
	8/02	R	9062－4K		
	8/04	J			

審査請求　未請求　請求項の数4（全 6 頁）

(21)出願番号　特願平4－220529

(22)出願日　平成4年(1992)8月20日

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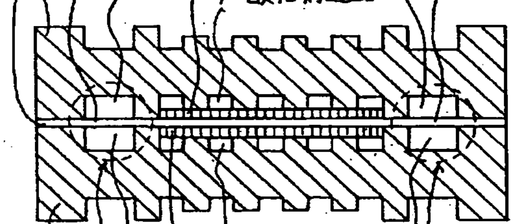
(54)【発明の名称】　固体高分子電解質型燃料電池のセル構造

(57)【要約】

【目的】組立作業が容易で、加湿性能がよく、燃料電池の冷却にも寄与できる加湿部が一体化された固体高分子電解質型燃料電池を得る。

【構成】イオン導電性を有する固体高分子膜２２と、その両面に密着して配された燃料電極３および酸化剤電極４とからなる単セルが、ガス不透過性板の両面の燃料電極および酸化剤電極それぞれに対向する部分に凹溝からなる燃料ガス通路６および酸化剤通路７を有するバイポーラプレート２５Ａ，２５Ｂを介して複数層積層された固体高分子電解質型燃料電池において、固体高分子膜が互いに対向する燃料電極および酸化剤電極の両側方に所定の長さ延長され、この延長部分を水分の透過膜として一方の延長部分２２Ｂ側に燃料ガスの加湿部３６，他方の延長部分２２Ａ側に酸化剤の加湿部３７を設けてなるものとする。



1

【特許請求の範囲】

【請求項１】イオン導電性を有する固体高分子膜と、その両面に密着して配された燃料電極および酸化剤電極とからなる単セルが、ガス不透過性板の両面の前記燃料電極および酸化剤電極それぞれに対向する部分に凹溝からなる燃料ガス通路および酸化剤通路を有するバイポーラプレートを介して複数層積層された固体高分子電解質型燃料電池において、前記固体高分子膜が互いに対向する前記燃料電極および酸化剤電極の両側方に所定の長さ延長され、この延長部分を水分の透過膜として一方の延長部分に燃料ガスの加湿部，他方の延長部分に酸化剤の加湿部を設けてなることを特徴とする固体高分子電解質型燃料電池のセル構造。

【請求項２】加湿部が、固体高分子膜の延長部分と、これを挟持する一方のバイポーラプレートに燃料ガス通路または酸化剤通路に連通する凹溝として形成されたガス加湿通路と、他方のバイポーラプレートの前記ガス加湿通路に対向する部分に独立した凹溝として形成された水補給通路とからなることを特徴とする請求項１記載の固体高分子電解質型燃料電池のセル構造。

【請求項３】固体高分子膜の２つの延長部分におけるガス加湿通路および水補給通路の配置が、固体高分子膜に対して互いに対称な位置に配されて、一方が燃料ガスの加湿部を、他方が酸化剤の加湿部を形成してなることを特徴とする請求項２記載の固体高分子電解質型燃料電池のセル構造。

【請求項４】ガス加湿通路が、これを通った燃料ガスまたは酸化剤がＵターンして燃料ガス通路または酸化剤通路に流入するよう形成されてなることを特徴とする請求項２記載の固体高分子電解質型燃料電池のセル構造。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明は、固体高分子膜を電解質膜として用いた固体高分子電解質型燃料電池スタック、ことに固体高分子膜を加湿するためのセル構造に関する。

【０００２】

【従来の技術】図４は固体高分子電解質型燃料電池の単セル構造を模式化して示す断面図であり、単セル１は、イオン導電性を有する固体高分子膜２と、その両面に密着するよう支持された燃料電極（アノード電極）３および酸化剤電極（カソード電極）４とで構成される。また、単セル１を挟持するバイポーラプレート５は導電性を有するガス不透過性板からなり、その燃料電極３に接する面側に凹溝として形成された燃料ガス通路６に燃料ガスとしての水素を、酸化剤電極４に接する面側に凹溝として形成された酸化剤通路７に酸化剤としての酸素を供給することにより、単セル１の一対の電極間で電気化学反応に基づく発電が行われる。なお、このように構成された単セル１の出力電圧は１Ｖ以下と低いので、単セル１とバイポーラプレート５を複数層積層してスタックを構成することにより、所望の出力電圧の固体高分子電解質型燃料電池が得られる。

2

【０００３】一方、イオン導電性を有する固体高分子膜１としては、例えばプロトン交換膜であるパーフロロカーボンスルホン酸膜（米国，デュポン社，商品名ナフィオン）を電解質膜として用いたものが知られており、分子中にプロトン（水素イオン）交換基を持ち、飽和含水することにより常温で２０Ω-cm 以下の比抵抗を示し、プロトン導電性電解質として機能するとともに、燃料ガスと酸化剤ガスの混合を防ぐ隔膜としても機能する。すなわち、アノード電極（燃料電極）側では水素分子を水素イオンと電子に分解するアノード反応（$H_2 \rightarrow 2H^+ + 2e^-$）が、カソード電極（酸化剤電極）側では酸素と水素イオンと電子から水を生成する電気化学反応（$2H^+ + 1/2\ O_2 + 2e^- \rightarrow H_2O$）なるカソード反応がそれぞれ行われ、全体として$H_2 + 1/2\ O_2 \rightarrow H_2O$なる電気化学反応が行われ、アノードからカソードに向かって外部回路を移動する電子により発電電力が負荷に供給される。

【０００４】上述のように、固体高分子電解質型燃料電池では、電解質膜を飽和含水させることにより、膜はプロトン交換膜として機能するものであるから、固体高分子電解質型燃料電池の発電効率を高く維持するためには固体高分子膜２中を飽和含水状態に維持するとともに、固体高分子電解質型燃料電池の運転温度を５０～１００°Ｃ程度に保持して固体高分子膜の比抵抗を低く保つ必要がある。このため、各単セル１の固体高分子電解質膜２はあらかじめ飽和量の水を含水させた状態でスタックの組立作業が行われる。ところが、運転温度を上記温度範囲に高めて発電を行うと、下記に示す固体高分子膜２の乾燥作用が発生し、固体高分子膜２を飽和含水状態に維持できず固体高分子電解質型燃料電池の発電効率が低下するという問題が発生する。すなわち、燃料ガスおよび酸化剤ガスにより電気化学反応で生成した水が系外に持ち出されるとともに、アノード反応において生成したプロトン$2H^+$が固体高分子膜中をアノードからカソードに向けて移動する際、プロトンに数分子の水が配向して一緒に移動し、燃料ガス，酸化剤とともに系外に持ち出されることにより、固体高分子膜の乾燥が進行する。

【０００５】そこで、このような事態を回避するために、反応ガス通路６および７に供給する反応ガス（燃料ガスおよび酸化剤）に水を添加して反応ガス中の水蒸気濃度（水蒸気分圧）を高め、固体高分子膜２からの水分の蒸発を抑えるよう構成したものが知られている。反応ガスの加湿方法としては、燃料電池の外部に温湯を溜めたタンクを用意し、この湯の中に反応ガスをバブリンクして加湿し、加湿した反応ガスを固体高分子電解質型燃料電池の各単セルに供給する外部加湿法が知られている。また、固体高分子電解質型燃料電池に隣接して加湿

部を設け、ここで加湿した反応ガスを各単セルに供給する内部加湿法も知られている。

【０００６】図５は内部加湿方式の従来の固体高分子電解質型燃料電池を示す模式図、図６は従来の内部加湿方式における加湿部を示す模式図である。図において、固体高分子電解質型燃料電池１０はその側壁に隣接して反応ガスの加湿部１１を備え、加湿した燃料ガスおよび酸化剤を各単セルの燃料ガス通路６および酸化剤通路７にそれぞれ供給する。加湿部１１は図６に示すように、電子導電性を持たない固体高分子膜（メンブランフィルター）を加湿用水透過膜１２Ａ，１２Ｂとし、それぞれ一方の面側が加湿水通路１３に対向し、他方の面が燃料ガス加湿室１６または酸化剤加湿室１７に対向するよう構成され、燃料電池の排熱により加熱された水により湿潤した加湿用水透過膜１２表面から水蒸気が発生し、この水蒸気により加湿された燃料ガスおよび酸化剤が固体高分子電解質型燃料電池１０の各単セルの燃料ガス通路６および酸化剤通路７にそれぞれ供給される。

【０００７】

【発明が解決しようとする課題】上述の外部加湿方式においては、タンクで加湿した反応ガスが燃料電池との間の配管中で凝縮するのを防ぐために、配管の断熱および加熱を必要とし、かつタンクの加熱用熱源を必要とするため、固体高分子電解質型燃料電池の熱効率の低下を招くという問題があり、かつ装置も大掛かりになるという欠点がある。

【０００８】一方上述の内部加湿方式においては、加湿部を燃料電池スタックに隣接して配置するので、水蒸気発生の熱源としての燃料電池の排熱の利用が容易であり、かつ加湿部と燃料電池の間のガス配管も簡単化できる利点がある。しかしながら、燃料電池とは別体のイオン導電性を持たない高分子膜を水分透過膜として使用した独立した装置であり、その部品点数も多く，組立作業が煩雑になるという問題がある。また、加湿部を単セルの層間に積層できれば、加湿用の補給水の蒸発潜熱を燃料電池の冷却に利用することが可能であり、加湿部を冷却板に兼用できると期待されるが、加湿用水透過膜が電子導電性を持たないため、単セルの層間に積層するとスタックの導電性が失われるため、加湿部を燃料電池の冷却板として兼用できないという問題も存在する。

【０００９】この発明の目的は、燃料電池スタックと一体化することにより、組立作業が容易で、加湿性能がよく、燃料電池の冷却にも寄与できる加湿部を備えた固体高分子電解質型燃料電池のセル構造を得ることにある。

【００１０】

【課題を解決するための手段】上記課題を解決するために、この発明によれば、イオン導電性を有する固体高分子膜と、その両面に密着して配された燃料電極および酸化剤電極とからなる単セルが、ガス不透過性板の両面の前記燃料電極および酸化剤電極それぞれに対向する部分に凹溝からなる燃料ガス通路および酸化剤通路を有するバイポーラプレートを介して複数層積層された固体高分子電解質型燃料電池において、前記固体高分子膜が互いに対向する前記燃料電極および酸化剤電極の両側方に所定の長さ延長され、この延長部分を水分の透過膜として一方の延長部分に燃料ガスの加湿部，他方の延長部分に酸化剤の加湿部を設けてなるものとする。

【００１１】また、加湿部が、固体高分子膜の延長部分と、これを挟持する一方のバイポーラプレートに燃料ガス通路または酸化剤通路に連通する凹溝として形成されたガス加湿通路と、他方のバイポーラプレートの前記ガス加湿通路に対向する部分に独立した凹溝として形成された水補給通路とからなるものとする。さらに、固体高分子膜の２つの延長部分におけるガス加湿通路および水補給通路の配置が、固体高分子膜に対して互いに対称な位置に配されて、一方が燃料ガスの加湿部を、他方が酸化剤の加湿部を形成してなるものとする。

【００１２】さらにまた、ガス供給通路を、これを通った燃料ガスまたは酸化剤がＵターンして燃料ガス通路または酸化剤通路に流入するよう形成してなるものとする。

【００１３】

【作用】この発明の構成において、固体高分子電解質型燃料電池の各単セルのイオン導電性を有する固体高分子膜を、燃料電極および酸化剤電極の両側方に所定の長さ延長し、この延長部分を水分の透過膜として一方の延長部分に燃料ガスの加湿部，他方の延長部分に酸化剤の加湿部を設けるよう構成した。すなわち、固体高分子膜を挟持する一方のバイポーラプレートに燃料ガス通路または酸化剤通路に連通する凹溝として形成されたガス加湿通路を、他方のバイポーラプレートのガス供給通路に対向する部分に独立した凹溝として形成された水補給通路とを設けて加湿部とするよう構成すれば、バイポーラプレートにあらかじめ形成する凹溝の形状をガス加湿通路，水補給通路に対応して形成しておくことにより、固体高分子電解質型燃料電池の積層構造を殆ど変えることなく一体化された反応ガスの加湿部を単セル毎に備えた固体高分子電解質型燃料電池を構成できるので、部品点数および組立工数の増加を回避する機能が得られる。また、各単セル毎に加湿部備えるので固体高分子膜の加湿性能に優れ、かつ固体高分子膜の延長部分から本体部分への水分の移行も期待できるので固体高分子膜の高い乾燥防止機能が得られる。さらに、単セルの両サイドに一体化した加湿部が、単セルの発電生成熱を水蒸気の蒸発潜熱として奪うので、加湿部が応答速度の速い冷却板を兼ね、固体高分子電解質型燃料電池の温度分布を改善する機能が得られる。

【００１４】さらに、固体高分子膜の２つの延長部分におけるガス供給通路および水補給通路の配置を、固体高分子膜に対して互いに対称な位置とするよう構成すれ

ば、一方の延長部分に燃料ガスの加湿部を、他方の延長部分に酸化剤の加湿部を、固体高分子電解質型燃料電池の構成に影響を及ぼさずに形成することができる。さらにまた、ガス供給通路を、これを通った燃料ガスまたは酸化剤がＵターンして燃料ガス通路または酸化剤通路に流入するよう形成すれば、加湿した反応ガスの供給通路を必要とせず、加湿部の所要面積を必要最小限に縮小できるとともに、水分を凝縮させることなく反応ガス通路に供給して固体高分子膜を効率よく加湿する機能が得られる。

【００１５】

【実施例】以下、この発明を実施例に基づいて説明する。図１はこの発明の実施例になる固体高分子電解質型燃料電池のセル構造を模式化して示す断面図、図２は実施例におけるバイポーラプレートを燃料ガス通路側から見た平面図、図３は実施例におけるバイポーラプレートを酸化剤通路側から見た平面図であり、従来技術と同じ構成部分には同一参照符号を付すことにより、重複した説明を省略する。図において、単セルを構成するイオン導電性を有する固体高分子膜２２が、これを介して互いに対向する燃料電極３および酸化剤電極４の両側方に所定の長さ延長され、この延長部分を水分の透過膜２２Ａ，２２Ｂとして一方の延長部分に燃料ガスの加湿部３６，他方の延長部分に酸化剤の加湿部３７が形成される。

【００１６】燃料ガスの加湿部３６は、固体高分子膜２２の延長部分２２Ｂを水分の透過膜とし、これを挟持する一方のバイポーラプレート２５Ａに燃料ガス通路６に連通する凹溝としての燃料ガス加湿通路２６を形成し、他方のバイポーラプレート２５Ｂの燃料ガス加湿通路２６に対向する部分に独立した凹溝からなる水補給通路２４を形成することにより、各単セルと一体化した燃料ガスの加湿部３６を備えた固体高分子電解質型燃料電池が構成される。また、酸化剤の加湿部３７としては、固体高分子膜２２の延長部分２２Ａを水分の透過膜とし、これを挟持する一方のバイポーラプレート２５Ｂに酸化剤通路７に連通する凹溝としての酸化剤加湿通路２７を形成し、他方のバイポーラプレート２５Ａの酸化剤加湿通路２７に対向する部分に独立した凹溝からなる水補給通路２３を形成することにより、各単セルと一体化した燃料ガスの加湿部３７を備えた固体高分子電解質型燃料電池が構成される。

【００１７】また、１つの単セルにおける燃料ガスの加湿部３６および酸化剤の加湿部３７は、固体高分子膜の２つの延長部分におけるガス加湿通路２６，２７と、水補給通路２３，２４との配置を、固体高分子膜に対して互いに対称な位置とすることにより、燃料ガス通路６に連通した燃料ガス加湿通路２６と、酸化剤通路７に連通した酸化剤加湿通路２７とを１枚の固体高分子膜２２の延長部分を利用する形で形成することができる。

【００１８】さらに、図２または図３に示すように、水補給通路２３，２４はバイポーラプレート２５Ａ，２５Ｂ外周側のシール部２８に連結して形成されたリブ２８Ｂにより、ガス通路６，７と画成され、シール部２８を貫通する補給水の入口２３Ａ，２４Ａと、出口２３Ｂ，２４Ｂを介して補給水の給排水がそれぞれ行われる。また、燃料ガスの加湿通路２６，または酸化剤の加湿通路２７は、燃料ガス通路６，酸化剤通路７との間にリブ２８Ａを備え、加湿通路を通った燃料ガスまたは酸化剤がＵターンして燃料ガス通路６または酸化剤通路７に流入するよう形成され、加湿通路で加湿された反応ガス中の水分を凝縮させることなく燃料ガス通路または酸化剤通路に供給できるとともに、加湿部が占める面積を最小限度に縮小することができる。

【００１９】実施例になるセル構造を有する単セルは、加湿部３６および３７中の補給水が、単セルの発電生成熱を単セルから直接，あるいは図示しない冷却板の延長部分から受けて加熱され、湿潤した水分透過膜２２Ａ，２２Ｂの表面で水蒸気が発生し、この水蒸気により加湿通路２６，２７内の反応ガスが加湿され、これに連通した燃料ガス通路６および酸化剤通路７に加湿された燃料ガスまたは酸化剤が供給される。

【００２０】このように構成されたセル構造を有する単セルの積層体として構成される固体高分子電解質型燃料電池においては、バイポーラプレートにあらかじめ形成する凹溝の形状をガス加湿通路，水補給通路に対応して形成しておくことにより、固体高分子電解質型燃料電池の積層構造を殆ど変えることなく一体化された反応ガスの加湿部を単セル毎に備えた固体高分子電解質型燃料電池を構成できるので、部品点数および組立工数の増加が回避されて製造コストの低減が可能になるとともに、各単セル毎に加湿部が設けられて反応ガスの加湿性能がよく、かつ湿潤した延長部分から直接水分が固体高分子膜の本体部分に移行して乾燥を防止する機能が加わるので、高度の乾燥防止性能を有するセル構造を備えた固体高分子電解質型燃料電池を経済的にも有利に得ることができる。

【００２１】また、単セルの両サイドに一体化した加湿部が、単セルの発電生成熱を水蒸気の蒸発潜熱として奪うので、加湿部が応答速度の速い冷却板の機能を兼ね、固体高分子電解質型燃料電池の温度分布を改善できる利点が得られる。

【００２２】

【発明の効果】この発明は前述のように、電解質膜としての固体高分子膜の延長部分を水分の透過膜として一方の延長部分に燃料ガスの加湿部，他方の延長部分に酸化剤の加湿部を設けるよう構成した。その結果、外部加湿方式の固体高分子電解質型燃料電池に比べ、加湿部が燃料電池と一体化されることにより加湿タンクおよびガス配管を必要とせず装置の構成を簡素化できるとともに、

燃料電池の生成熱を水蒸気発生用熱源として直接利用できるので熱効率が高く、かつ加湿部を各単セルが備えることにより加湿性能の高いセル構造を備えた固体高分子電解質型燃料電池を経済的にも有利に提供することができる。

【００２３】また、燃料電池に加湿部を併設した従来の内部加湿方式の固体高分子電解質型燃料電池に比べ、燃料電池本体と一体化した加湿部を各単セル毎に備え、かつ燃料電池の生成熱を水蒸気発生用熱源として直接利用できるため、単セル温度の変化に対する加湿量の応答速度高く、固体高分子膜の延長部分から本体部分への水分の直接補給も期待できるので、優れた固体高分子膜の乾燥防止効果が得られる。また、一体化されることにより部品点数およびその組立工数を低減できるので、製造コストを大幅に低減できる経済効果が得られる。さらに、加湿部に供給される補給水が冷却水としても機能するので、各単セルに冷却板を設けたと同様の冷却効果が得られ、単セルの面方向および固体高分子電解質型燃料電池の積層方向の温度分布を改善してセル特性を向上する波及効果も期待できる。

【図面の簡単な説明】

【図１】この発明の実施例になる固体高分子電解質型燃料電池のセル構造を模式化して示す断面図

【図２】実施例におけるバイポーラプレートを燃料ガス通路側から見た平面図

【図３】実施例におけるバイポーラプレートを酸化剤通路側から見た平面図

【図４】固体高分子電解質型燃料電池の単セル構造を模式化して示す断面図

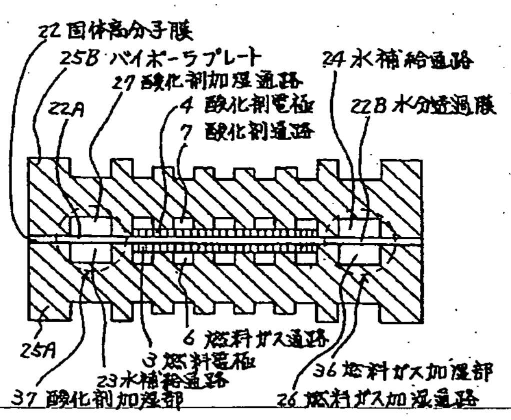
【図５】内部加湿方式の従来の固体高分子電解質型燃料電池を示す模式図

【図６】従来の内部加湿方式における加湿部を示す模式図

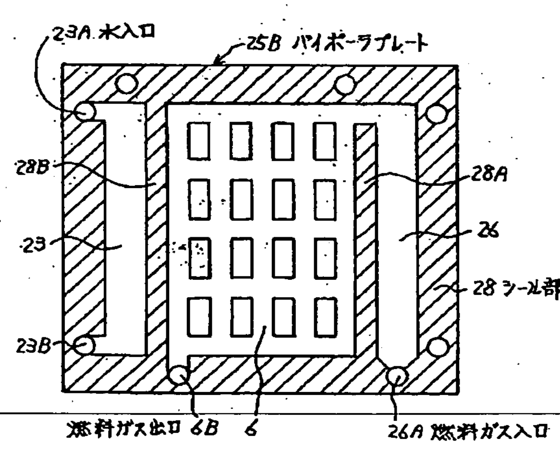
【符号の説明】

１　単セル
２　固体高分子膜
３　燃料電極
４　酸化剤電極
５　バイポーラプレート
６　燃料ガス通路
７　酸化剤通路
８　ガスシール部（リブ）
１０　固体高分子電解質型燃料電池（スタック）
１１　加湿部
１２　加湿用水透過膜
１３　加湿水通路
１６　燃料ガス加湿室
１７　酸化剤加湿室
２２　固体高分子膜
２２Ａ　固体高分子膜の延長部分（水分透過膜）
２２Ｂ　固体高分子膜の延長部分（水分透過膜）
２３　水補給通路
２４　水補給通路
２５Ａ　バイポーラプレート
２５Ｂ　バイポーラプレート
２６　燃料ガス加湿通路
２７　酸化剤加湿通路
２８　シール部
２８Ａ　リブ（ガスＵターン用）
２８Ｂ　リブ（水補給通路の画成用）
３６　燃料ガス加湿部
３７　酸化剤加湿部

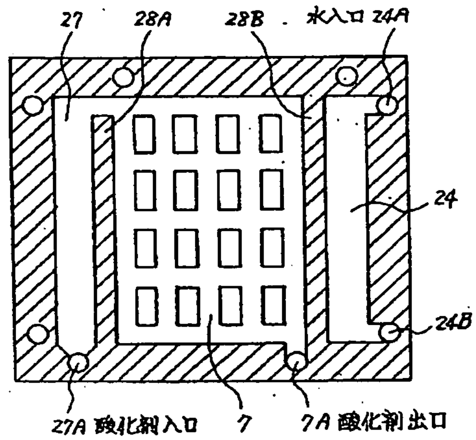
【図１】



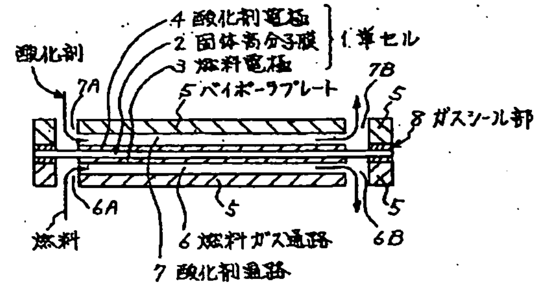
【図２】



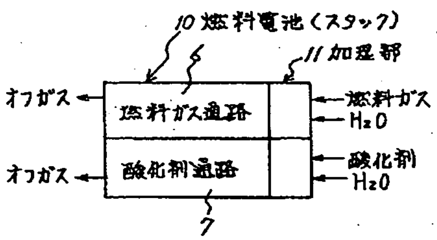
【図3】


27
28A
28B
水入口 24A
24
24B
27A 酸化剤入口
7
7A 酸化剤出口

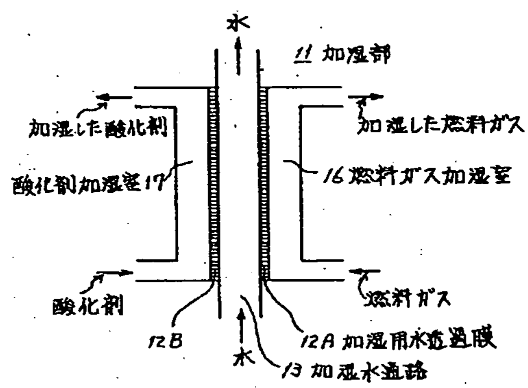
【図4】


4 酸化剤電極
2 固体高分子膜
3 燃料電極
1 単セル
酸化剤
7A
5 バイポーラプレート
7B
5
8 ガスシール部
6A
5
5
燃料
6 燃料ガス通路
6B
7 酸化剤通路

【図5】


10 燃料電池(スタック)
11 加湿部
オフガス
燃料ガス通路
燃料ガス
H2O
オフガス
酸化剤通路
酸化剤
H2O
7

【図6】


水
11 加湿部
加湿した酸化剤
加湿した燃料ガス
酸化剤加湿室17
16 燃料ガス加湿室
酸化剤
燃料ガス
12B
12A 加湿用水透過膜
水
13 加湿水通路